

3.4 Geology and Soils

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3.4.1 Studies and Coordination

Method of Analysis

This analysis is based on the findings of the *SR 509/South Access Road EIS Discipline Report: Geology and Soils* (CH2M HILL February 2000), *SR 509/South Access Road EIS: South Airport Link* (CH2M HILL August 2001), and *SR 509/South Access Road EIS: I-5 Improvements Report* (CH2M HILL October 2001). These discipline reports, which are incorporated into this FEIS by reference, evaluated construction and operation impacts of the proposed project build alternatives and the No Action Alternative on geology and soils resources. For the purpose of this analysis, the project area is the area adjacent to the alignment of the proposed SR 509 and South Access Road alternatives and the I-5 improvements. The evaluation included inventory and assessment of the geology, soils, topography, and unique physical features of the project area through review of geologic surveys, soil surveys, and topographic maps; sensitive areas maps for King County and the Cities of Des Moines and SeaTac; and previous technical studies, engineering reports, and borehole logs. A field reconnaissance of the project area was also performed. Areas subject to severe risk of erosion, landslide, and earthquake damage were identified. Based on this information, probable project impacts were assessed, including the effects of excavating, filling, stockpiling, paving, and draining on erosion and on steep and unstable slopes. Soils and geologic conditions that could constrain project design, construction, and operation were also identified.

Coordination with Agencies and Groups

The following agencies and groups were contacted during preparation of this Revised DEIS:

- U.S. Natural Resources Conservation Service, Renton, Washington, (formerly the Soil Conservation Service)
- WSDOT
- King County Department of Development and Environmental Services
- City of SeaTac
- City of Des Moines
- City of Kent

3.4.2 Affected Environment

Topography

The landscape of the project area was primarily formed by glacial and alluvial processes. It consists of a broad glacial plain that has been dissected by stream drainages and the Green River. The glacial uplands have gently rolling topography with slopes that generally range from nearly level to about 15 percent. Valleys and ravines occur along channels of the Des Moines, Massey, Miller, and McSorley creek drainages. Slopes along these drainages generally range from 15 to 40 percent; slopes greater than 40 percent occur in some areas. The Green River valley runs along the eastern edge of the project area and is marked by bluffs of up to 350 feet along its east valley wall. Elevation in the project area ranges from about 450 feet above mean sea level (msl) in the glacial uplands to about 40 feet above msl in the Green River valley.

Geology and Soils

The project area is located on the Des Moines Drift Plain. The drift plain consists of glacial sediments, nonglacial sediments, and recent alluvium. Most of the surface material in the project area was deposited during the Vashon glaciation, the last major glaciation. Deposits of the older Salmon Springs glaciation are exposed in some areas. The drift plain is underlain by Tertiary volcanic and sedimentary rock.

Soils mapped in the project area by the Soil Conservation Service (SCS) (1973) are shown in Figures 3.4-1 and 3.4-2. Alderwood and Everett soils occur on glacial uplands and terraces, and are the most common and abundant soils in the project area. Norma, Indianola, Kitsap, Bellingham, Seattle, and Tukwila soils occur less extensively.

Alderwood gravelly sandy loams are moderately well-drained soils that have a substratum of consolidated till at a depth of approximately 24 to 40 inches. Arents-Alderwood materials are Alderwood soils that have been substantially disturbed by urban development, but still have many features of undisturbed Alderwood soils. In both soils, surface horizons have moderately rapid permeability, but the till substratum is very slowly permeable, creating a high water table in winter. Erosion hazard is slight on slopes of 0 to 6 percent, slight to moderate on slopes of 6 to 15 percent, and severe to very severe on slopes greater than 15 percent. Slippage potential along the till contact is moderate to severe on slopes greater than 15 percent.

Everett gravelly sandy loams formed in glacial outwash. They are somewhat excessively drained soils that are underlain by very gravelly sand at a depth of 18 to 40 inches. Permeability is rapid. Erosion hazard is slight on slopes of 0 to 6 percent, slight to moderate on slopes of 6 to 15 percent, and severe to

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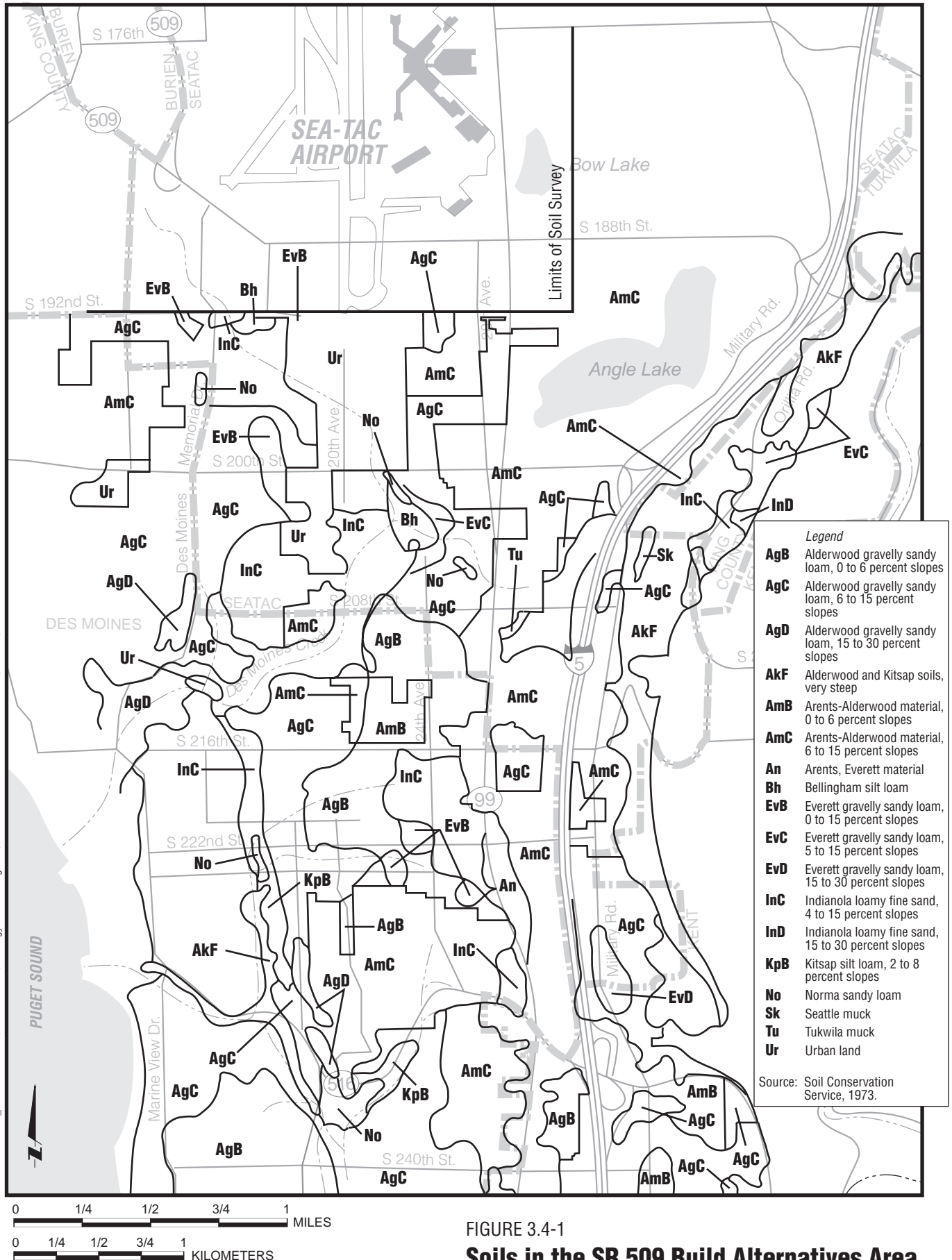


FIGURE 3.4-1

Soils in the SR 509 Build Alternatives Area

SR 509: Corridor Completion/I-5/South Access Road
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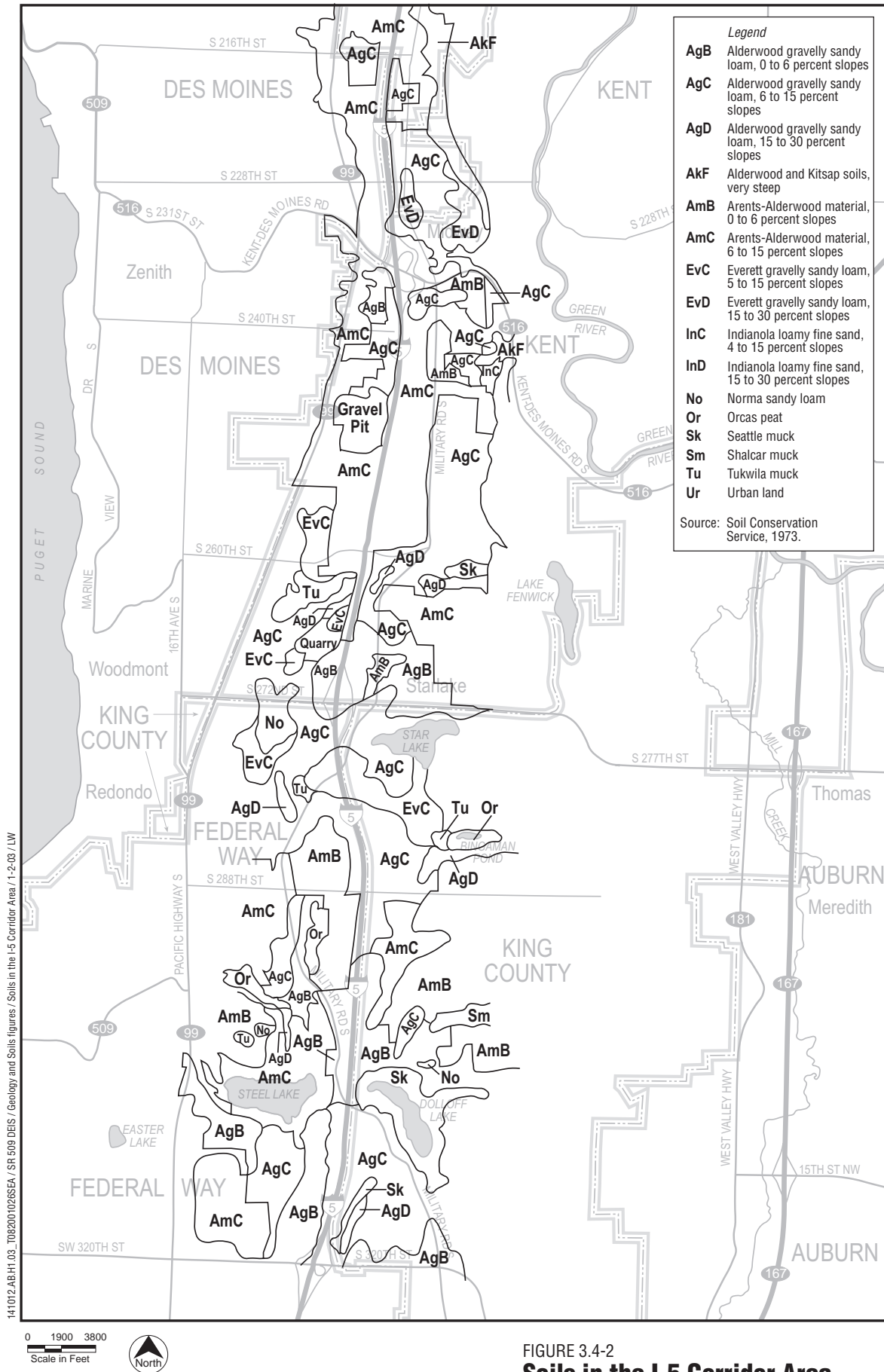


FIGURE 3.4-2

Soils in the I-5 Corridor Area

SR 509: Corridor Completion/I-5/South Access Road
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very severe on slopes greater than 15 percent. Arents-Everett materials are Everett soils that have been disturbed by urban development, but have features similar to undisturbed Everett soils. They are level to gently sloping, and erosion hazard is slight.

Indianola loamy fine sands are somewhat excessively drained soils formed in sandy, stratified recessional outwash. Permeability is rapid. Slopes range from 4 to 15 percent, and erosion hazard is slight to moderate.

Kitsap silt loams are moderately well-drained soils that formed in glacial lake deposits and are found on terraces and strongly dissected terrace fronts. They have a substratum of platy, silty sediments at a depth of 18 to 40 inches. Permeability is moderate above the substratum and very slow within it. Water perches on top of the substratum in winter. Erosion hazard is slight to moderate on slopes of 2 to 8 percent, moderate to severe on slopes of 8 to 15 percent, and severe to very severe on slopes greater than 15 percent. Slippage potential along the substratum contact is moderate to severe on slopes greater than 8 percent.

Bellingham silt loams and Norma sandy loams are poorly drained soils formed in alluvium. Permeability is slow, slopes are less than 2 percent, and erosion hazard is slight. Bellingham soils occur in small depressions on glacial till plains. Norma soils occur in basins on glacial uplands and along stream channels. The water table is at or near the soil surface during the winter rainy season.

Seattle mucks and Tukwila mucks are poorly drained organic soils formed in depressions on till plains and in river and stream valleys. Permeability is moderate, and the high water table is at or near the surface during winter. Slopes are less than 1 percent, and there is little or no erosion hazard.

Site Seismicity

The project area lies within the Puget Sound region and represents an area of high seismic risk. Since 1945, there have been seven earthquakes of magnitude 5.0 and greater with epicenters near Puget Sound (Pacific Northwest Seismograph Network 2002). Seismic activity in the region is a function of tectonic events and processes that occur as a result of collision between the Juan de Fuca plate and the North American plate. Geophysical investigations suggest that earthquakes may also occur from a network of faults beneath the Puget Sound basin. However, few active faults have been conclusively discovered because of the mid-crust depths of most of the earthquakes in the Puget Sound region and the thick overburden of geologically recent glacial and nonglacial sediments. No active faults are mapped in the project area (USGS 2002a). A north-west trending quaternary fault, referred to as the Coast Range Boundary fault, is mapped in the vicinity of the project, but its location is uncertain (USGS 2002b).

A seismic event may trigger slippage in areas susceptible to landslides or cause liquefaction in areas where relatively loose, fine-grained cohesionless soils occur below the water table. The following section discusses seismic hazards in the project area.

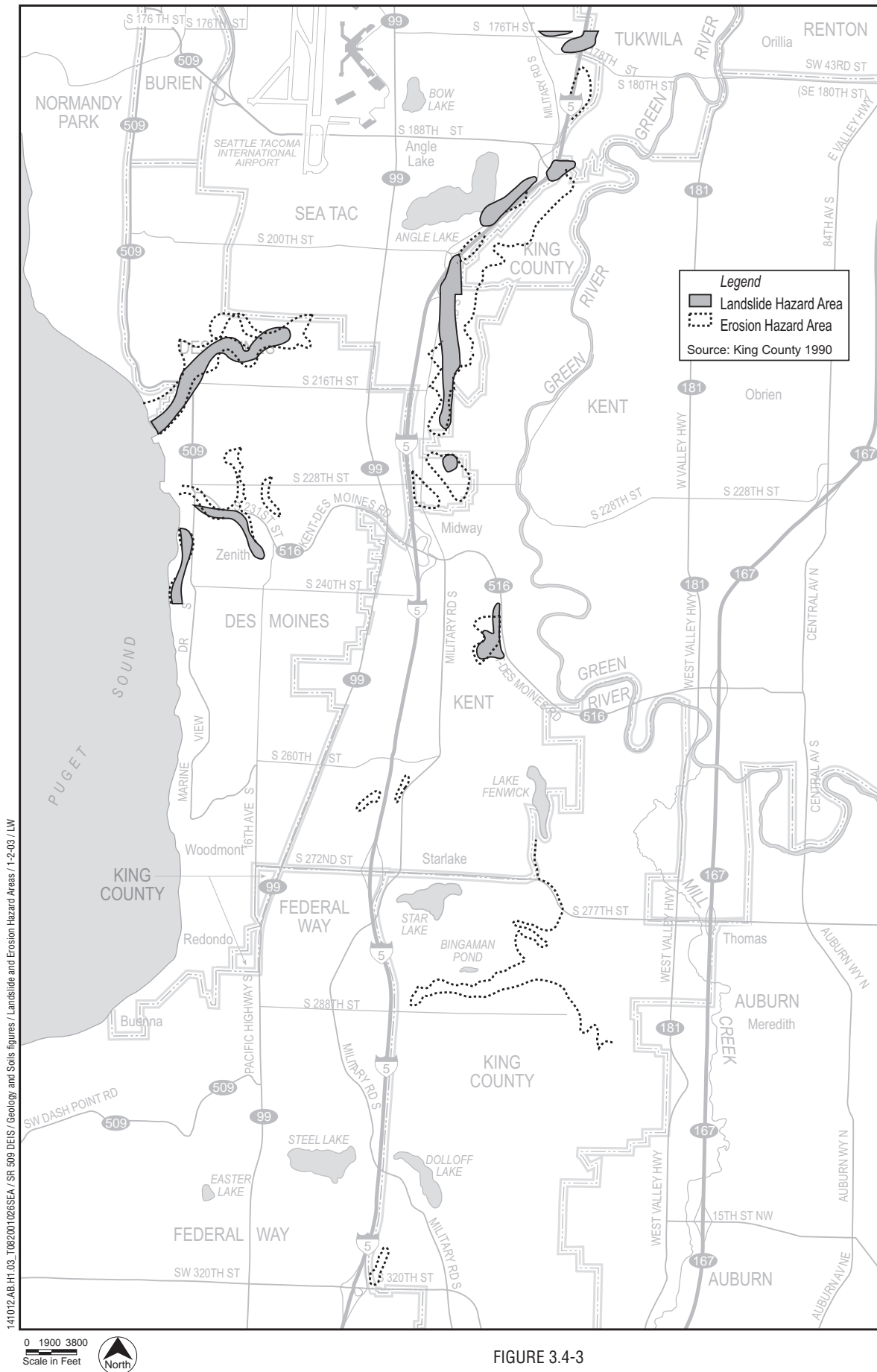
Sensitive Areas

Portions of the project area are designated as landslide, steep slope, erosion, and seismic hazard areas as defined in ordinances of King County (2001) and the Cities of Des Moines (2000), SeaTac (2001), Kent (2001), and Federal Way (2001). The intent of these ordinances is to regulate areas that have been identified as sensitive to help prevent and avoid activities that could have adverse impacts on property. Additional areas have been mapped as seismic hazard areas by Palmer et al. (1994, 1995).

Landslide hazard areas are sloping areas that are subject to a severe risk of landslide. They are defined as any area with a combination of slopes greater than 15 percent, impermeable soils, and springs or groundwater seepage. They are often associated with unconsolidated glacial deposits and alluvial fans. Steep slope hazard areas are landslide hazard areas on 40 percent or greater slopes. Erosion hazard areas are defined as areas of soils that are rated as having severe to very severe erosion hazard by the Natural Resources Conservation Service (SCS). They generally occur where slopes are greater than 15 percent. Landslide and erosion hazard areas identified within the project area are shown in Figure 3.4-3. These hazard areas occur along portions of the Green River and Des Moines Creek valley walls.

The proposed project is located within a seismic zone that represents an area susceptible to moderately high seismic activity. Seismic hazard areas are defined as areas subject to severe risk of earthquake damage as a result of seismically induced liquefaction. Liquefaction occurs when loose, saturated, and relatively cohesionless soil deposits temporarily lose strength because of earthquake shaking. Primary factors controlling the development of liquefaction include intensity and duration of strong ground motion, characteristics of subsurface soil, in situ stress conditions, and depth to groundwater. Potential effects of soil liquefaction include temporary loss of bearing capacity and lateral soil resistance, liquefaction-induced settlement, and lateral spreading.

Seismic hazard areas identified within the project area are shown in Figure 3.4-4. They generally occur in lacustrine deposits in the northern part of the project area, along a segment of Des Moines Creek, on the Green River floodplain, and in areas of fill.



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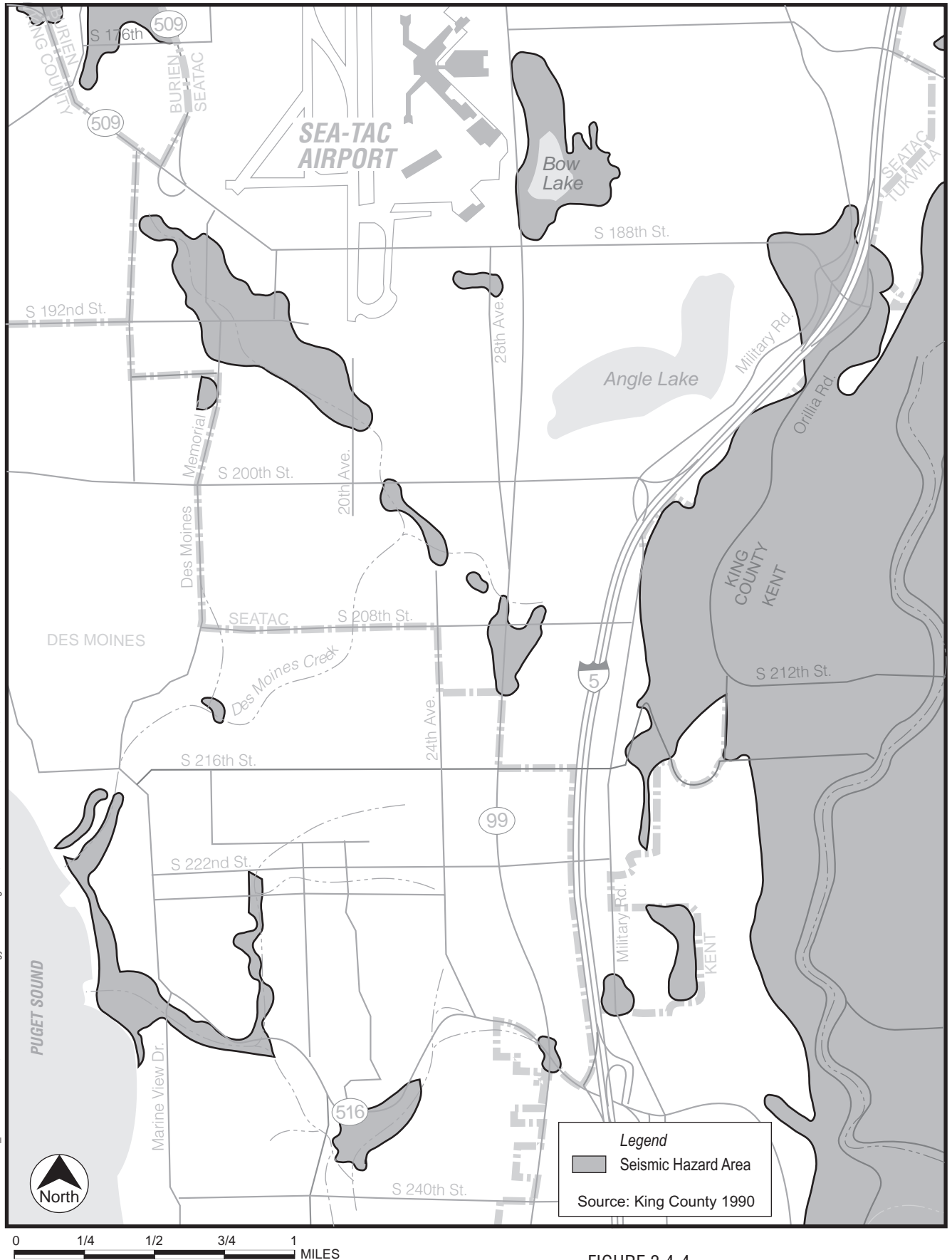


FIGURE 3.4-4

Seismic Hazard Areas

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3.4.3 Environmental Impacts

Alternative A (No Action)

The No Action Alternative would not result in any impacts on earth resources.

Impacts Common To All Build Alternatives

After construction, exposed soils would be either paved or revegetated. Little erosion and sedimentation would be expected after establishing vegetation. The amount of impervious surface would increase.

The project area is located within the Puget sound Region, an area susceptible to moderately high seismic activity. During a seismic event, the site would be subjected to ground motion. The potential for strong ground motion in the project area is considered no greater than for the Puget Sound in general. Moderate levels of earthquake shaking should be anticipated during the design life of the facility.

All of the build alternatives would cross seismic hazard areas. Liquefaction of soils in these areas during an earthquake could result in vertical and lateral displacements of structures, embankments, and paved areas. The liquefaction potential of all potential seismic hazard areas would be confirmed during the design stage of the preferred alternative. Design of structures to resist seismic forces and also secondary effects such as liquefaction might be required.

Alternative B

Alternative B would create about 4.2 million cubic yards (cy) of cut material and require about 3.5 million cy of fill material, including the I-5 improvements (Inca January 2000, CH2M HILL October 2001). This alternative would produce more cut material and would require more fill than Alternative C2, and more cut material but less fill material than Alternative C3. Consequently, the potential for erosion and sedimentation impacts for Alternative B would be the highest of the build alternatives.

Alternative B would cross five seismic hazard areas. The SR 509 extension would cross two seismic hazard areas: (1) near the intersection of SR 99 and South 208th Street where a bridge over SR 509 is proposed, and (2) north of South 192nd Street. A third seismic hazard area would be crossed by the South Access Road, south of South 200th Street. A fourth area would be crossed by the widened South 200th Street, west of the South Access Road. A fifth seismic hazard area would be crossed by SR 516 in the vicinity of SR 99 as part of the reconstructed I-5/SR 516 interchange. Liquefaction of soils in these areas during an earthquake could result in vertical and lateral

displacement of the bridge at the SR 99 crossing, as well as the embankments and paved roads at the other affected areas.

The South Access Road alignment would cross a small area mapped as Norma and Bellingham soils by the National Resources Conservation Service (formerly SCS). These soils could contain strata of compressible silty and organic material. Near the south end of the Alternative B SR 509 extension, the roadway would cross a small area of organic soil, Tukwila muck. Areas where these three soils occur might need to be excavated prior to roadway/embankment construction. These unsuitable materials would be removed from the project area, unless deemed suitable for landscaped areas.

Alternative C2 (Preferred)

Alternative C2 would create about 3.2 million cy of cut material and require about 1.2 million cy of fill material, including the I-5 improvements (Inca January 2000, CH2M HILL October 2001b). This alternative would produce the least amount of cut and fill material of all the build alternatives. The potential for erosion and sedimentation impacts for Alternative C2 would be the lowest of all the build alternatives.

Alternative C2 would cross five seismic hazard areas. These areas are: (1) near the intersection of SR 99 and South 208th Street where a bridge over SR 509 is proposed; (2) just northwest of the intersection of SR 99 and South 208th Street; (3) between South 204th Street and South 200th Street along the alignment; (4) north of South 200th Street near Des Moines Memorial Drive; and (5) west of Des Moines Memorial Drive between South 192nd Street and the existing SR 509 terminus. Liquefaction of soils in these areas during a seismic event could cause vertical and lateral displacements of soils under roadways, in embankment fill, and of the bridge footings at the SR 99 crossing.

Similar to Alternative B, small areas of the Norma sandy loam, Tukwila muck, and Bellingham silty loam are crossed by the alignment. These areas of potentially compressible soils might need to be excavated and replaced under roadways, embankments, and bridge footings.

Alternative C3

Construction of Alternative C3 would create about 3.8 million cy of cut material and require about 3.6 million cy of fill material, including the I-5 improvements (Inca January 2000, CH2M HILL October 2001b). This would be the more cut and fill material than for Alternative C2, and less cut material but more fill material than for Alternative B. The potential for erosion and sedimentation impacts for Alternative C3 would be higher than for Alternative C2, but less than Alternative B.

Alternative C3 would cross four seismic hazard areas. These areas are: (1) south of the intersection of SR 99 and South 208th Street where a bridge for SR 99 is proposed to go over SR 509; (2) between South 204th Street and South 200th Street along the alignment; (3) just south of Des Moines Memorial Drive between South 192nd Street and South 200th Street; and (4) west of Des Moines Memorial Drive between South 192nd Street and the existing SR 509 terminus. There is potential for liquefaction of soils in these areas during a seismic event. Liquefaction could cause vertical and lateral displacements of soils under roadways, embankment fills, and bridge footings at the SR 99 crossing.

Similar to Alternatives B and C2, small areas of the Norma sandy loam, Tukwila muck, and Bellingham silty loam are crossed by the alignment. These areas of potentially compressible soils might need to be excavated from under roadways, embankments, and bridge footings.

3.4.4 Mitigation Measures

A geotechnical investigation would be conducted as part of the design phase. Specific recommendations for liquefaction mitigation, subgrade preparation, roadway embankment, cut and fill, slope stability, foundation design, retaining structures, dewatering measures, and erosion control plans would be prepared prior to any construction. Suitable waste sites for unsuitable excavated soils would be identified prior to construction.

Structures would be designed to meet current seismic standards. Potential impacts of soil liquefaction could be mitigated by removing and replacing the loose materials with compacted fill materials. The need for removing and replacing would be evaluated on a case-by-case basis for the individual structural elements potentially impacted.

Retaining walls or other slope protection could be necessary where embankment fills need to be minimized. Where deep fills would be required, material should be selected from sources that allow construction of a compact base, yet afford fairly rapid drainage. Deep fill areas and retaining structures could require cross drainage.

3.4.5 Construction Activity Impacts and Mitigation

Construction Activity Impacts

Each of the build alternatives would require land clearing, grubbing and removing topsoil, cutting slopes, filling for roadway embankments, and paving roadways. Excavation and fill would result in minor topographic changes. Exposure of soils during excavation would increase the potential for erosion and downslope transport of sediment.

Most construction activity would occur in areas of dense to very dense glacial outwash and glacial till soils. These materials generally provide adequate subgrade support for roadways, embankments, and retaining structures. Settlement or stability problems with standard cuts and fills (2:1 or flatter) are not anticipated. Steepening slopes in areas of clean outwash, however, could increase the potential for soil erosion.

Prior to fill placement, overexcavation could be required in areas with soft organic or silt soils and areas with saturated soils. Existing fill that overlies native soil is likely of variable consistency and quality and also could require removal. The unsuitable soils would require removal from the project area, unless deemed suitable for landscaped areas.

Shallow groundwater is likely to be encountered in areas with poorly drained soils, areas adjacent to streams, wetland areas, and some areas underlain by till. Dewatering would be required for excavation below groundwater levels. Permanent drainage systems could be necessary in some areas to maintain the water table below the depth of excavation and to maintain stability of fill slopes and retaining structures.

Increased noise, dust, and traffic from hauling fill and excavated materials would be temporary impacts in the project vicinity. The magnitude of these impacts would depend on the location of borrow and waste sites, land uses along the haul routes, the duration of hauling operations, and construction phasing.

Mitigation Measures

A detailed erosion and sedimentation control plan would be required as part of the construction contract specifications. The plan would follow best management practices (BMPs). Drainageway protection and sediment retention would be approved by regulatory agencies prior to project construction (see Section 3.5, *Water Quality*). Additionally, construction activities would require a permit under the stormwater rules of the National Pollutant Discharge Elimination System (NPDES). Regular maintenance would be required for any permanent detention and sedimentation ponds constructed as part of the proposed project.

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